

WHAT IS CLAIMED IS:

- 1                   1.       A catheter comprising:  
2                   a flexible body comprising a proximal end and a distal end;  
3                   a rigid housing rotatably coupled to the distal end of the flexible body, the  
4 housing comprising a window; and  
5                   a tissue debulking assembly disposed at least partially within the rigid  
6 housing, wherein deflection of the rigid housing relative to the flexible body exposes the  
7 tissue debulking assembly through the window.
- 1                   2.       The catheter of claim 1 wherein the tissue debulking assembly  
2 comprises a rotatable cutter.
- 1                   3.       The catheter of claim 2 wherein the housing and flexible body define a  
2 channel having a longitudinal axis, the catheter further comprising a drive shaft positioned  
3 within the channel, wherein the drive shaft is attachable to a driver for rotating the cutter.
- 1                   4.       The catheter of claim 3 wherein the rigid housing deflects in a  
2 direction opposite of the window about an axis that is substantially orthogonal to the  
3 longitudinal axis of the flexible body so as to position the cutter adjacent a target tissue.
- 1                   5.       The catheter of claim 1 wherein the rigid housing is coupled to the  
2 flexible body with a joint, wherein movement of the tissue debulking assembly actuates  
3 deflection of the rigid housing about the joint.
- 1                   6.       The catheter of claim 5 further comprising a ramp positioned on the  
2 rigid housing opposite of the window, wherein proximal movement of the tissue debulking  
3 assembly over the ramp deflects the rigid housing and exposes the tissue debulking assembly  
4 out of the window.
- 1                   7.       The catheter of claim 1 wherein the tissue debulking assembly is  
2 movably between a first position and a second position, wherein the tissue debulking  
3 assembly in the first position closes the window.
- 1                   8.       The catheter of claim 7 wherein the movable tissue debulking  
2 assembly in the second position is positioned beyond an outer diameter of the rigid housing.

1           9.     The catheter of claim 8 wherein the tissue debulking assembly in the  
2 second proximal position moves a longitudinal axis of the debulking assembly to an angled  
3 position relative to the longitudinal axis of the rigid housing and out of the window beyond  
4 an outer diameter of the housing.

1           10.    The catheter of claim 8 wherein the tissue debulking assembly in the  
2 second position moves a longitudinal axis of the rigid housing to an offset parallel position  
3 relative to the longitudinal axis of the tissue debulking assembly.

1           11.    The catheter of claim 1 further comprising a flexible distal tip coupled  
2 to the rigid housing, wherein at least one of the distal tip and rigid housing comprise a  
3 collection chamber.

1           12.    The catheter of claim 11 wherein the flexible distal tip and flexible  
2 body comprise lumens for receiving a guidewire.

1           13.    The catheter of claim 1 wherein the tissue debulking assembly  
2 comprises a RF electrode, a laser, or an ultrasound emitter.

1           14.    A catheter for removing material out of a body lumen, the catheter  
2 comprising:  
3               a body comprising a proximal portion and a distal portion, wherein the  
4 proximal portion and distal portion each define an axis;  
5               a cutting window on the distal portion of the body; and  
6               a cutter movably disposed within at least a portion of the distal portion of the  
7 body, wherein the cutter is movable from a first position in which the cutter is aligned with  
8 the axis of the distal portion and disposed in the body, to a second position in which the cutter  
9 is at an angled or offset position relative to the axis of the distal portion of the body and  
10 exposed through the window.

1           15.    The catheter of claim 14 wherein the second position is proximal of the  
2 first position.

1           16.    The catheter of claim 14 wherein the cutter in the second position  
2 extends beyond an outer diameter of the distal portion of the body.

1                   17.     The catheter of claim 14 wherein the proximal portion of the body is  
2 flexible and the distal portion of the body is relatively rigid.

1                   18.     The catheter of claim 14 wherein the cutter is rotatable and coupled to  
2 a cutter driver with a drive shaft.

1                   19.     The catheter of claim 18 wherein the cutter driver comprises a single  
2 input device that controls the rotation and axial movement of the cutter.

1                   20.     The catheter of claim 14 comprising a collection chamber coupled to  
2 the distal portion of the body.

1                   21.     The catheter of claim 20 comprising a first lumen coupled to the  
2 collection chamber and a second lumen coupled to the body, wherein the first and second  
3 lumen are configured to receive a guidewire.

1                   22.     The catheter of claim 20 wherein the cutter is movable to a third  
2 position, wherein the third position is distal of the first and second position and urges severed  
3 material into the collection chamber.

1                   23.     The catheter of claim 14 comprising a ramp disposed in the distal  
2 portion of the body, wherein proximal movement of the cutter over the ramp guides the cutter  
3 to the second position.

1                   24.     A catheter for removing material from a body lumen, the catheter  
2 comprising:  
3                   a body comprising a proximal portion, a distal portion, an inner channel  
4 defining a longitudinal axis, and a side opening cutting window disposed on the distal portion  
5 of the body;  
6                   a cam;  
7                   a drive shaft positioned within the inner channel , wherein a proximal end of  
8 the drive shaft is attachable to a drive motor; and  
9                   a rotatable and axially movable cutter coupled to a distal end of the drive  
10 shaft, wherein the rotatable cutter is movable over the cam to deflect the distal portion  
11 relative to the proximal portion and expose the cutter through the cutting window.

1                   25.     The catheter of claim 24 wherein the distal portion is pivotally coupled  
2 to the proximal portion via a pivot joint.

1                   26.     The catheter of claim 25 wherein the joint is positioned proximal of the  
2 cutting window.

1                   27.     The catheter of claim 25 wherein the distal portion of the housing is  
2 rotated about the joint and is urged against the body lumen when the cutter is exposed out of  
3 the cutting window.

1                   28.     The catheter of claim 25 further comprising a flexible distal tip  
2 attached to the distal portion, wherein the proximal portion is flexible and the distal portion is  
3 rigid.

1                   29.     The catheter of claim 28 wherein the rigid distal portion has a length  
2 between approximately 6 mm and 8 mm.

1                   30.     The catheter of claim 24 wherein the cutter has a serrated cutting edge.

1                   31.     The catheter of claim 24 wherein the cutter has a smooth cutting edge.

1                   32.     A catheter comprising:  
2 a flexible body comprising a proximal end and a distal end;  
3 a rigid housing rotatably coupled to the distal end of the flexible body, the  
4 housing comprising a cutting window; and  
5 a debulking assembly movably disposed within the rigid housing, wherein  
6 movement of the debulking assembly from a first position to a second position rotates the  
7 rigid housing relative to the flexible body.

1                   33.     The catheter of claim 32 further comprising a ramp in the rigid  
2 housing, wherein movement of the debulking assembly over the ramp moves the debulking  
3 assembly out of the cutting window beyond an outer diameter of the rigid housing.

1                   34.     The catheter of claim 32 wherein the first position is distal to the  
2 second position, wherein the debulking assembly in the first distal position closes the cutting  
3 window.

1 35. The catheter of claim 32 wherein the housing and flexible body define  
2 a channel, wherein the debulking assembly is a rotatable cutter, the catheter further  
3 comprising a drive shaft positioned within the channel and attachable to a drive unit for  
4 rotating the cutter.

1 36. The catheter of claim 35 wherein the housing defines a longitudinal  
2 axis, wherein the cutter and drive shaft are rotatable about the longitudinal axis.

1 37. The catheter of claim 36 wherein the cutter pivots about an axis that is  
2 orthogonal to the longitudinal axis when the cutter moves out of the cutting window.

1 38. The catheter of claim 37 wherein the rigid housing comprises a flexible  
2 joint, wherein moving the cutter rotates the housing about the flexible joint.

1 39. A method of removing material from a body lumen, the method  
2 comprising:

3 delivering a catheter comprising a tissue debulking device to a target site in  
4 the body lumen;

5 deflecting a distal portion of the catheter relative to a proximal portion of the  
6 catheter to expose the tissue debulking device; and

7 debulking the body lumen.

1 40. The method of claim 39 wherein debulking comprises:  
2 rotating the tissue debulking device about a first axis; and  
3 exposing the tissue debulking device through a cutting window in the catheter.

1 41. The method of claim 40 wherein exposing comprises sliding the tissue  
2 debulking device against a cam surface.

1 42. The method of claim 40 wherein the first axis is a longitudinal axis of  
2 the catheter.

1 43. The method of claim 40 further comprising advancing the catheter in  
2 the body lumen to move the rotating tissue debulking device through material in the body  
3 lumen.

1 44. The method of claim 39 further comprising packing severed material  
2 into a collection chamber.

1 45. The method of claim 39 wherein deflecting comprises urging the tissue  
2 debulking device against the material in the body lumen.

1 46. The method of claim 39 wherein delivering comprises attaching a  
2 guidewire to a monorail delivery assembly on the catheter.

1 47. The method of claim 39 wherein the target site is a stent.

1 48. The method of claim 39 wherein deflecting is carried out by moving  
2 the tissue debulking device from a first position to a second position.

1 49. A method of debulking a body lumen, the method comprising:  
2 moving a tissue debulking device from a first position to an exposed second  
3 position;

4 deflecting a distal portion of the catheter against the body lumen to position  
5 the exposed tissue debulking device in a desired position; and

6 passing the catheter and tissue debulking device through the material in the  
7 body lumen to debulk the body lumen.

1 50. The method of claim 49 wherein an axis of the distal portion of the  
2 catheter is offset from an axis of a proximal portion of the catheter.

1 51. The method of claim 49 wherein deflecting drops the distal portion of  
2 the catheter out of a path of the debulking device.

1 52. The method of claim 49 further comprising rotating the tissue  
2 debulking device.

1 53. The method of claim 49 further comprising parting off material  
2 invaginating the cutting window.

1 54. The method of claim 49 further comprising collecting severed material  
2 in a distal collection chamber.

1 55. The method of claim 54 further comprising packing the severed  
2 material into the collection chamber.

1 56. The method of claim 49 wherein the catheter defines a longitudinal  
2 axis, wherein the tissue debulking device in the first position is aligned with the longitudinal  
3 axis, and the tissue debulking device in the second position is at an angle to the longitudinal  
4 axis.

1 57. A method of debulking a body lumen, the method comprising:  
2 providing a catheter comprising a proximal portion, a distal portion, and a  
3 tissue debulking assembly; and  
4 deflecting a distal portion of the catheter against the body lumen to urge the  
5 tissue debulking assembly adjacent a target tissue in the body lumen.

1 58. The method of claim 57 wherein deflecting comprises moving the  
2 tissue debulking assembly from a first position to a second position.

1 59. The method of claim 57 wherein the distal portion comprises a flexible  
2 distal tip and a rigid distal housing.

1 60. The method of claim 57 comprising rotatably coupling the proximal  
2 portion to the distal portion with a joint.

1 61. A kit comprising:  
2 a catheter comprising a proximal portion rotatably coupled to a distal portion,  
3 wherein the distal portion includes a side-opening window and a tissue debulking device;  
4 instructions for use in removing occlusive material from a body lumen  
5 comprising moving the tissue debulking device from a first position to a second position so as  
6 to expose the tissue debulking device through the window and to rotate the distal portion  
7 relative to the proximal portion, and advancing the catheter through the body lumen to  
8 contact the tissue removal device with the occlusive material; and  
9 a package for holding the catheter and instructions.

1 62. A method of debulking a body lumen, the method comprising:  
2 exposing a cutter out of a cutting window of a catheter; and

3                   advancing the catheter to move the cutter through occlusive material in the  
4 body lumen.

1                   63.     A method of debulking a body lumen, the method comprising:  
2                   moving a rotating cutter out of a side facing cutting window in a catheter;  
3                   deflecting a distal portion of the catheter to urge the cutter toward a target  
4 material; and  
5                   advancing the cutter through the material by moving the catheter.

1                   64.     The method of claim 63 wherein the catheter defines a longitudinal  
2 axis, wherein urging comprises deflecting the distal portion of the catheter off of the  
3 longitudinal axis.

1                   65.     The method of claim 64 wherein moving comprises moving the cutter  
2 off of the longitudinal axis.

1                   66.     The method of claim 63 wherein moving comprises pivoting the cutter  
2 out of the cutting window.

1                   67.     The method of claim 63 wherein advancing comprises moving the  
2 entire catheter distally through the body lumen.

1                   68.     The method of claim 63 further comprising packing material into a  
2 collection chamber.